PATENT SPECIFICATION

712,431

Date of Application and filing Complete Specification: Nov. 22, 1951.

No. 27430/51.

Application made in United States of America on Nov. 30, 1950.

Complete Specification Published: July 21, 1954.

Index at acceptance:—Classes **2(3),** C3A10E1; **91,** F1D(1: 2), G1A1; **and 95,** A13.

COMPLETE SPECIFICATION

Improvements in or relating to Rust Preventing Compositions and process

I, GEORGE HUGO VON FUCHS, a citizen of the United States of America, of 1221, Garfield Avenue, Niagara Falls, State of New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to chemical compounds which have rust-preventive properties, to lubricating and other compositions containing such compounds, and to processes for preventing the rusting of ferrous metal surfaces.

It is well known that rusting of iron and steel surfaces takes place rapidly in the presence of water. It has been found that such surfaces even when covered with pure mineral oil will still rust if water is mixed with the oil since the metal surfaces are normally hydrophilic and the oil adjacent thereto is readily displaced by films of water. Thus, in internal combustion engines, the condensation of water vapor in the crank case may provide sufficient water mixed with the oil to bring about rusting of various parts and fittings of the engine.

The problem of preventing rusting of machinery and apparatus is a serious one to the solving of which much effort has been devoted. The problem is complicated by the fact that, other factors being equal, the formation of rust on ferrous metal surfaces is promoted by an increase in temperature.

Such surfaces can be prevented from rusting even under conditions which would otherwise favor rusting by establishing thereon a firmly attached hydrophobic film. Such a film prevents access of water to the metal surface and therefore no rust can form. Obviously, materials which will provide hydrophobic films cannot be applied in water solution. In some cases a hydrophobic film may be provided by supplying a suitable material in an organic solvent or by flowing such a material in molten condition over the metal surface. Neither of these methods is, however, satisfactory in the case of apparatus or machinery in which there is movement of contacting parts.

A hydrophobic or water-repellent film is most conveniently established on the ferrous metal surfaces in such apparatus or machinery with a rust-preventive material dissolved in the lubricant employed in the machinery. A number of compositions have been suggested for use in this manner as rust preventives.

It is generally believed that rust preventives are harmful to the stability of the lubricant in which they are used. In many cases there is basis for this belief as the rust preventive employed attacks and dissolves to a considerable extent the ferrous metal and/or other metals, such as copper, present in the system. The metal reaction products thus formed tend to promote decomposition of the lubricant and thereby materially reduce the useful life thereof.

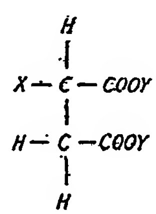
Many of the materials previously suggested for addition to lubricants for the prevention of rust are ineffective. Others, although having some degree of effectiveness in preventing rusting, are undesirable because they promote emulsification of water with the lubricant. Still others, such as alkyl and alkenyl succinic acids which have carbon chain lengths of 12 or more carbon atoms in the substituent group are in general not satisfactory for one reason or another. Such alkenyl succinic acids are usually quickly broken down and removed by oxidation at temperatures above atmospheric, thus losing their effectiveness. Branched chain alky-substituted acids such, for example, as iso-octadecyl succinic acid, while stable and sufficiently soluble for use, are quite corrosive towards copper and other metals commonly employed in apparatus such as engines, pumps and turbines. On the other

[*Price* 2/8]

hand, straight chain alkyl-substituted succinic acids, such as *n*-octadecyl succinic acid, although much less corrosive than the branched chain acids, are solids of high melting point and at rdinary temperatures their solubility in petroleum lubricating oils is less than 0.001 per cent. Consequently, extensive commercial use of the latter mentioned compounds as rust preventives has been impossible since it is obvious that oils containing useful amounts of such compounds could not be stored at ordinary temperatures without danger of the substantially insoluble compound settling out or being removed by filtration.

It is has now been found that compounds having the desirable non-corrosive and rust-preventive properties of the straight chain alkyl-substituted succinic acids referred to above, together with a greatly increased solubility in mineral oil lubricants may be prepared by partially esterifying certain straight chain alkyl-substituted succinic acids with certain aliphatic alcohols. The alcohols employed are monohydric alcohols having no more than three carbon atoms in a straight chain and the esterification is carried no further than is required to react one of the carboxyl groups of the acid.

Mono-esters, such as, for example, octadecyl succinic acid mono-methyl ester and tetradecyl succinic acid mono-propyl ester, having the general formula



in which X is a straight chain alkyl radical containing at least 12 carbon atoms, one Y is an alkyl radical containing not more than three carbon atoms in a straight chain, and the other Y is hydrogen, are the partial esters employed according to the present invention and have been found very effective as rust-preventive agents. In solution in a mineral oil they have been found effective as rust preventive cutting oils. The effectiveness of such esters as rust preventives is surprising since previously it has been believed that the rust-preventive action of alkyl and alkenyl succinic acids results from the reaction of both of the carboxyl groups of the acids with the surface of the protected metal. Such a conclusion appeared reasonable when it is considered that mono-carboxylic acids are of slight or no value as rust preventives in the small percentages normally used, and are actually corrosive.

Alkyl and alkenyl succinic acids are conveniently prepared by the reaction of olefins with maleic anhydride. The resultant product is an alkenyl succinic acid anhydride which may be converted into the corresponding alkyl succinic anhydride by hydrogenation. The general process is disclosed in United States Patent No. 2,055,456, issued September 22, 1936, to Egon Eichwald, and United States Patent No. 2,411,215, issued November 19, 1946, to Mearl A. Kise *et al.* Esters of the alkyl succinic acid may be conveniently formed by merely heating together stoichiometric amounts of the desired alcohol and the anhydride of the desired acid. The extent of esterification may be determined by determination of the acid number of the resultant product.

A large number of tests have been devised to determine the effectiveness and value of rust-preventive materials admixed with lubricants. Among the more valuable of such tests are those which determine:

1. The ability of the material to form adherent water-repellent films on metal surfaces when dissolved in bulk lubricant.
2. The resistance of any water-repellent film thus formed to hydrolysis or decomposition by water in the absence of bulk lubricant.
3. The ability of such a film to maintain itself under oxidizing conditions.
4. The resistance of ferrous metal surfaces coated with such a water-repellent film to attack by aqueous salt solutions.
5. The tendency of the material to attack and dissolve metals such as copper.
6. The tendency of the material to contribute to or promote the formation of water emulsions in the lubricant.
7. The tendency of the material to affect the stability of the lubricant.

Many such tests have been made with rust-preventive mono-esters of the group mentioned above and experiments involving the use of such compounds with both petroleum lubricants and representative synthetic lubricants have been carried out.

In the following two tables there are set forth the results of tests run with oils containing a number of rust preventive mono-esters to determine the corrosiveness of such compounds on copper. The test here employed is that described in an article by Edward W. McGovern in the September, 1938, issue of "Arctic Service News" for testing the corrosiveness of refrigerator oils. It involves the immersion of a coil of clean copper wire in an oil bath which is maintained at a temperature of 200° F. From time to time samples of the oil are removed and tested for dissolved copper with a carbon tetrachloride solution of diphenyl thiocarbazone. The sensitivity of this method of copper detection is very high, easily indicating the presence f 1 p.p.m of copper.

A medium viscosity white petroleum oil

(approximately 175—340 Saybold universal seconds at 100° F.) was used in all of the tests. In the tests for which results are shown in Table A, the oil contained no oxidation inhibitor. Consequently, the copper was attacked more quickly because of the tendency of such oils when held at the test temperature to form peroxides which readily react to form corrosive organic acids. This will be evident from a comparison of the result of the blank test (no rust preventive) in Table A with the corresponding test, recorded in Table B, which was run with an oxidation-inhibited oil.

TABLE A

Rust Preventive	Concentration per cent.	Cu Determination Negative hours
None	—	48
Iso-octadecyl succinic acid	0.1	9
n-octadecyl succinic acid mono-methyl ester	0.1	144
” ” ” ” ethyl ”	0.1	156
” ” ” ” *n*-propyl ”	0.1	84
” ” ” ” iso ” ”	0.1	120
” ” ” ” *n*-butyl ”	0.1	12
” ” ” ” sec ” ”	0.1	156
” ” ” ” tert ” ”	0.1	180+
” ” ” ” *n*-amyl ”	0.1	12

It will be observed from the results in Table A that the iso-octadecyl succinic acid as well as the mono-esters of alcohols having a straight carbon chain of more than three carbon atoms attacked the copper coil substantially before it was attacked by the oil decomposition products. On the other hand, the mono-esters of alkyl succinic acids in which the alcohol has no more than three carbon atoms in a straight chain, which for convenience will be referred to hereinafter merely as "rust-inhibitive mono-esters," are shown to be lacking in harmful effect.

Table B, following, shows the results of tests in which the copper wire coil was immersed in oil which was of the same type as that used in the tests of Table A but which contained 0.25 per cent. of di-tert-butyl-*p*-cresol as an inhibitor of oil oxidation.

TABLE B

Rust Preventive	Concentration per cent.	Cu Determination Negative hours
None	—	180+
Iso-octadecyl succinic acid	0.1	47
n-octadecyl succinic acid mono-methyl ester	0.1	180+
” ” ” ” ethyl ”	0.1	180+
” ” ” ” *n*-propyl ”	0.1	180+
” ” ” ” iso ” ”	0.1	180+
” ” ” ” *n*-butyl ”	0.1	132
” ” ” ” sec ” ”	0.1	180+
” ” ” ” tert ” ”	0.1	180+
” ” ” ” *n*-amyl ”	0.1	50

The foregoing Tables, A and B, set forth the results of comparative tests of the corrosive effect of iso-octadecyl succinic acid and mono-esters of *n*-octadecyl succinic acid on copper as representative of the metals with which lubricants are frequently in contact. In actual service the rust preventive would normally not be employed in a concentration as great as 0.1 per cent., the higher concentration being used in the tests to accentuate the differences in corrosiveness.

The ability of a material suggested for use as a rust-preventive to establish an adherent water-repellent film on a ferrous metal surface immersed in an oil solution of the material is preferably determined by the A.S.T.M. Steam-Turbine Oil Rusting Test (D 665-49T). The procedure involves sus-

pending a polished steel rod in a bath of oil which contains a definite percentage of the proposed rust preventive and which is maintained at 140° F. and constantly stirred, and subsequently, after a water-repellent film has had an opportunity to form, adding distilled water while continuing the stirring. From time to time the steel specimen is examined for rust spots.

When subjected to the A.S.T.M. test just referred to the rust-inhibitive mono-esters when used, even in concentrations as low as 0.001 per cent., in a medium viscosity white petroleum oil containing 0.25 per cent. di-tert-butyl-*p*-cresol as an oxidation inhibitor protected the steel rods from any trace of rusting for more than twenty-four hours.

The adherence or tenacity of the water-repellent film on the steel specimens used in the A.S.T.M. Rusting Test was determined by the supplement to that test described in The Texas Company publication, "Lubrication," in the issue of May, 1944, pages 49 and 50. In the supplemental test the specimens were removed from the oil and immersed in distilled water for 24 hours during which period the water was agitated and maintained at a temperature of 140° F. At the end of the 24 hour test period no sign of rusting was observed on any of the specimens treated with the rust-preventive mono-esters described herein.

The results of the two last-mentioned tests clearly show the ability of the alkyl succinic acid mono-esters of the present invention to form strongly adherent, hydrophobic films on ferrous metal surfaces and thus to prevent rusting of the metal even under conditions otherwise favorable for attack by rusting.

Another rigorous test for rust-preventive materials is provided by the method described in A.S.T.M. Designation D943-47T. This test simulates in a high degree very severe service conditions which may be encountered in the use of industrial lubricants by bubbling moist oxygen through cylinders of oil in each of which a dual coil wound of iron wire and copper wire is suspended. The results in Table C, below, were obtained with a medium viscosity petroleum white oil which was of the same type as used in the tests of Tables A and B and which contained 0.25 per cent. di-tert-butyl-*p*-cresol as an oil oxidation inhibitor.

TABLE C

Rust Preventive	Concentration	Time Before Rusting
	per cent.	hours
None	—	<24
Iso-octadecenyl succinic acid	0.01	55
n-octadecyl succinic acid*	0.01	720+
n-octadecyl succinic acid mono-methyl ester	0.01	720+
" " " " ethyl "	0.01	720+
" " " " *n*-propyl "	0.01	720+
" " " " iso " "	0.01	720+
" " " " sec-butyl "	0.01	720+
" " " " tert " "	0.01	720+

*Dissolved in hot oil because of lack of solubility cold.

The test employed in obtaining the data in Table C is also a measure of the tendency of the rust preventive material to affect the stability of the oil in the bath. Such tendency is determined by periodically, during the period of the test, finding the neutralization value of the oil. Using the procedure set forth in A.S.T.M. Designation 974-48T for determining the neutralization values (that is, the total acid number) of the oil specimens used, it was found that during the test periods the neutralization values of all of the oils containing rust-inhibitve mono-esters was less than 0.05. This indicates that the rust preventives of the present application do not adversely affect oil stability.

The resistance of steel specimens coated with water-repellent films of various mono-esters of the present invention to attack by an aqueous salt solution was determined by the so-called Static Water Drop Corrosion Test described by Baker *et al* in Industrial and Engineering Chemistry, Vol. 41, January, 1949, at page 137, using a medium viscosity petroleum white oil (approximately 175—340 Saybolt Universal seconds at 100° F.) as a carrier, a test temperature of 140° F., and a concentration of rust-preventing agent of 0.1 per cent. The test was, however, modified, as suggested elsewhere by one of the authors, by placing a drop of synthetic sea water in the cup of each specimen instead of a drop of distilled water. This modification greatly increases the severity of the test.

The synthetic sea water used was prepared according to the method described in

A.S.T.M. Designation: D 665-49T, "Tentative Method of Test for Rust-Preventing Characteristics of Steam-Turbine Oil in the Presence of Water," by dissolving the specified amounts of the following salts in 1000 ml. of distillled water.

$NaCl$	- -	24.54 grams
$MgCl_2.6H_2O$	-	11.10 "
Na_2SO_4	- -	4.09 "
$CaCl_2$	- -	1.16 "
KCl	- - -	0.69 "
$NaHCO_3$	- -	0.20 "
KBr	- - -	0.10 "
H_3BO_3	- -	0.03 "
$SrCl_2.6H_2O$	-	0.04 "
NaF	- - -	0.003 "

The following table sets forth the results of the thus modified Static Water Drop Corrosion Test with various mono-esters and dibasic acids.

TABLE D

Rust Preventive	Concentration	Appearance of Rust
	per cent.	hours
None	—	<1
Iso-octadecyl succinic acid	0.1	300+
n-octadecyl succinic acid mono-methyl ester	0.1	300+
" " " " ethyl "	0.1	300+
" " " " *n*-propyl "	0.1	300+
" " " " iso " "	0.1	300+
" " " " *n*-butyl "	0.1	<16
" " " " iso " "	0.1	300+
" " " " sec " "	0.1	300+
" " " " tert " "	0.1	300+
" " " " *n*-amyl "	0.1	<16

As pointed out by Baker *et al* in the article referred to above, effectiveness in preventing corrosion for a week, 168 hours, is regarded as satisfactory. Prolonging the test period to over 300 hours without failure of the novel rust-preventive materials of the present invention clearly shows their effectiveness.

The lack of tendency of the rust inhibitive mono-esters to promote the formation of stable water emulsions with the oils in which they are used was shown during the tests recorded in Table C. The test conditions were favorable to emulsification as they involved agitating the oil and water together. However, with the rust-inhibitive mono-esters no emulsions were formed during the test periods which did not break, with separation of the phases, within two or three minutes after discontinuance of the agitation. Serious emulsification was caused, however, by the iso-octadecenyl succinic acid.

The rust-preventive mono-esters of the present invention have been found effective not only with mineral oil but also with a number of synthetic lubricants. In this connection, considerable work has been done with oils comprising derivatives of polyalkylene glycols, and fluids and lubricants are available commercially under the Registered Trade Mark "Ucon." These fluids can be formed by the reaction of alkylene oxides with aliphatic monohydric alcohols, and they are essential addition products comprising complex mixtures of molecules having polyoxyalkylene chains of different lengths and varying internal arrangements. Further description of typical fluids of this nature can be found in United States Patent 2,448,664, issued to Harvey R. Fife and Frederick H. Roberts on September 7th, 1948.

It was found that the solubility of the mono-methyl and mono-ethyl esters of octadecyl succinic acid in a typical polyoxyalkylene glycol lubricant, sold under the symbol LB-300X by Carbide and Carbon Chemicals Division of Union Carbide and Carbon Corporation, is of the same order as that of iso-octadecenyl succinic acid. Moreover, both mono-esters remained soluble to at least the extent of one per cent. at temperatures as low as $-10°$ F. The low temperature solubility of the rust-preventive materials is important since synthetic oils of this type are used extensively in hydraulic installati ns

where they may be subjected to low temperatures for long periods of time.

The same synthetic lubricant (LB-300X) containing 2.0% of the mono-methyl ester of octadecyl succinic acid in solution was found to pass satisfactorily the A.S.T.M. Steam Turbine Oil Rusting Test (D665-49T), referred to above, by inhibiting rusting of the steel rod for a period of 24 hours. It also passed the supplemental film tenacity test with distilled water. Even when the distilled water of the rusting test was replaced by synthetic sea water (described above) no rust appeared for 24 hours.

In automotive engine tests a polyalkylene glycol synthetic oil ("Ucon" brand fluid LB-300X) containing one of the rust-preventive mono-esters of the present invention was found to perform exceedingly well as shown by the following:

TEST I

A standard automobile engine was run at full throttle—4500 r.p.m.—for 50 hours using the synthetic oil mentioned above with the addition of 2.0 per cent. of the mono-methyl ester of octadecyl succinic acid as lubricant. The lubricant temperature was maintained at 195° F. and the coolant temperature at 170° F. After completion of the test the engine was dismantled. Upon inspection, it was then found to be in excellent condition. Cleanliness, bearing weight losses and wear measurements showed no more than normal differences between results obtained with LB-300X alone and the same lubricant to which the mono-ester had been added.

TEST II

A crankcase lubricant consisting of the polyalkylene glycol synthetic oil LB-300X mentioned above plus 2.0 per cent. of the mono-methyl ester of octadecyl succinic acid was run in a Chevrolet automobile engine under the standard Coordinating Research Council L-4 Procedure for determining oxidation characteristics of heavy-duty crankcase oils. The engine operated at 1350 r.p.m., 30 b.hp., for 36 hours with a lubricant temperature of 280° F. and a coolant temperature of 200° F.

Inspection of the engine at the conclusion of the test and analysis of samples of the used lubricant revealed the same freedom from varnish and sludge deposits and excellent oxidation stability btained from the base fluid alone.

The low wear of rings, journals and wrist-pins which was found, contrasted with the abnormally high piston-ring wear resulting from a comparative test in which 2 per cent. of iso-octadecenyl succinic acid was added to the synthetic oil as a rust inhibitor.

TEST III

The Cordinating Research Council FL-2 test procedure which is referred to by Allbright, Nelson and Raymond in Industrial and Engineering Chemistry, Vol. 41 (1949), pp. 987—902, and is used to evaluate the performance of crankcase lubricants at low engine operating temperatures was employed with a Chevrolet automobile engine and a crankcase lubricant consisting of the polyalkylene glycol synthetic oil LB-300X mentioned above together with 2.0 per cent. of the mono-methyl ester of octadecyl succinic acid. The engine was run for 40 hours at 2500 r.p.m., 45 b.hp., with a lubricant temperature of 155° F. and a coolant temperature of 95° F. Under these conditions the rust-inhibited lubricant gave an excellent performance with normal engine cleanliness, low wear, and no unusual bearing corrosion.

The ability of the half-esters of the present invention to greatly diminish the corrosion of ferrous metals is further demonstrated in the following table which gives results of a further refinement of the Static Water Drop Corrosion Test referred to above. In this refinement advantage is taken of the sensitivity of the reaction of catechol with ferrous ions and the intense blue colour of the ferrous catecholate formed with only traces of ferrous ions to detect incipient rusting of ferrous metal surfaces.

The tests were conducted in the same manner and with specimens of the same type as employed in the Static Water-Drop Corrosion Test except that (a) after soaking for the specified period the oil was permitted to drain from the steel specimens for 10 minutes while they were held at 140° F., (b) the aqueous drop was distilled water containing 1 per cent. catechol in solution and was placed on the resulting oil-coated specimen instead of in the oil bath, and (c) the oil-coated specimens were held at room temperature while in contact with the aqueous drop. The following Table E sets forth the results of these tests.

TABLE E

Lubricant	Time for Appearance of Colour (Catechol in distilled water) Without Rust Preventive		With Rust Preventive			
	min.	sec.	Compound	%	hr.	min.
None (Fresh steel surface)	—	10	—	—	—	—
White mineral oil (med. visc.)	1	—	A	0.1	3	—
Synthetic oil No. 1	1	10	A	1.0	—	50
Synthetic oil No. 2	1	30	A	1.0	3	—
Synthetic oil No. 3	3	—	A	1.0	3	—
White mineral oil (med. visc.)	1	—	B	0.1	—	20
" " " " "	1	—	C	0.1	—	45
" " " " "	1	—	D	0.1	3	—

In the preceding table synthetic oil No. 1 was a medium viscosity (approximately 175—340 Saybolt Universal seconds at 100° F.) polyalkylene glycol oil identified as "Ucon" brand fluid LB-270, synthetic oil No. 2 was a low viscosity (approximately 120—175 Saybolt Universal seconds at 100° F.), low pour point oil produced by the polymerization of ethylene to give an average molecular weight of about 250, and synthetic oil No. 3 was di(2-ethylhexyl) sebacate, sold under the name "Plexol" —201. The last mentioned oil is representative of the diester type synthetic lubricants which are formed by reacting branched chain aliphatic alcohols such as 2-ethyl hexanol with straight chain dibasic acids such as sebacic and adipic acids. The diester synthetic oils are expensive but have very low viscosities (approximately 120—175 Saybolt Universal seconds at 100° F.) and are used for the lubrication of instruments and similar purposes where corrosion is very undesirable.

The rust preventive compounds identified and listed in Table E by the letters A, B, C, and D are respectively the mono-methyl ester of octadecyl succinic acid, the mono-methol ester of dodecyl succinic acid, the mono-methyl ester of tetradecyl succinic acid, and the mono-methyl ester of hexadecyl succinic acid.

It will be seen from the data in Table E that the production of ferrous ions from the surface of the specimens is inhibited by the mono-esters employed so that rusting of the steel would be prevented by the use of such compounds for prolonged periods of time.

The rust-preventive mono-esters of the present invention may also be employed with good results in solution in other organic media. Thus, for example, slushing oil or compound formed of a low viscosity mineral oil containing 1 per cent. of a rust preventive mono-ester is easily applied by dipping, painting or spraying. The water repellent film formed by the mono-ester provides substantially permanent rust protection for the coated ferrous metal surface even after the oil has been wiped off. The viscous oils or greases formerly required to given even temporary protection from rust are difficult to remove whereas the low viscosity oil may be easily wiped from the metal surface.

Rust resistance can be imparted to fresh ferrous metal surfaces by the incorporation of the rust-preventive mono-esters of the present invention in the cutting oils or coolants used in machining, grinding and similar fabricating operations on the metal. Temporary rust inhibitors are now frequently used in such fluids but no lasting water-repellent film is left on the metal surfaces. Ordinary cutting oils or coolants containing a small amount, in the order of 1—2 per cent., of a rust-preventive mono-ester of an alkyl-substituted succinic acid leave the metal surfaces with a durable long-lasting film which prevents rusting thereof.

It will also be evident that organic fluids used for many other purposes which may come into contact with iron or steel surfaces may be compounded with the rust-preventing mono-esters to prevent the rusting of such surfaces. Thus, for example, transformer oils, fluids used in hydraulic systems and torque converters, and fluids employed for heat transfer if mixed with 0.01—0.1 per cent. of one of the rust-preventive mono-esters will prevent rusting in the systems in which they are used. Rust-preventive mono-esters may also be used effectively in small amounts in anti-freeze fluids, flushing oils, and gasoline, fuel oils and other liquid petroleum, hydrocarbons with or without other materials added for other purposes.

Water-repellent, rust-preventing films may also be provided on ferrous metal surfaces by deposition of rust-preventive mono-esters from solutions of organic solvents. The mono-esters readily dissolve in a number of organic solvents such ,for example, as carbon tetrachloride, benzene, kerosene, naphtha, and

the mixtures of alcohols and benzene commonly used as cleaners for metal parts.

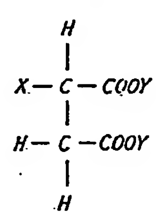
As will be seen from the foregoing, the alkyl-substituted succinic acid mono-esters f the present invention are highly effective in preventing the rusting of ferrous metals. They are, moreover, capable of being used widely and conveniently since they are readily soluble in liquid petroleum hydrocarbons and in a large variety of other organic fluids although substantially insoluble in water. Mixtures of different rust-preventive mono-esters, may, of course, be used where desired as may also mixtures of one of more rust-preventive mono-esters and one of more alkyl or alkenyl succinic acids.

Although the use of an oxidation inhibitor in oils or other organic rust-preventing fluids containing a rust-preventive mono-ester is not a necessity, it will usually be desirable since in many cases the stability of the oil or fluid will thereby be considerably improved. The amount of such inhibitor will vary with the organic material used, but generally will be within a range of from 0.0025 to 5.0 per cent. Besides the phenol type inhibitor di-tert-butyl-*p*-cresol mentioned previously, oxidation inhibitors of other types, such as phenyl-alphanaphthylamine and pheno-thiazine may be used. The rust-preventive mono-esters are compatible with many of the other additives which are widely used in lubricants and hence may be used in oils containing such additives as pour point depressants, and extreme pressure additives.

It is to be understood that concentrations and percentages mentioned or specified herein are by weight and not by volume.

What I claim is:—

1. The process of preventing the corrosion of ferrous metal surfaces which comprises applying to such surfaces a solution in an organic medium of an ester of an alkyl succinic acid having the general formula



in which X is a straight chain alkyl radical containing at least 12 carbon atoms, one Y is an alkyl radical containing not more than 3 carbon atoms in a straight chain, and the other Y is hydrogen.

2. A process as set forth in claim 1 in which said organic medium is a liquid petroleum hydrocarbon.

3. A process as set forth in claim 1 in which said organic medium is a liquid lubricating material.

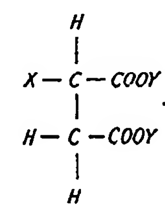
4. A process as set forth in claim 1 in which said rganic medium is a mineral oil.

5. A process as set forth in claim 1 in which said organic medium is a liquid solvent.

6. A process as set forth in claim 1 in which said ester is the mono-tert-butyl ester of octadecyl succinic acid.

7. A process as set forth in claim 1 in which said ester is the mono-methyl ester of octadecyl succinic acid.

8. A rust-preventive composition comprising a major proportion of an organic medium having in solution therein a minor proportion of an ester of an alkyl succinic acid having the general formula



in which X is a straight chain alkyl radical containing at least 12 carbon atoms, one Y is an alkyl radical containing not more than 3 carbon atoms in a straight chain, and the other Y is hydrogen.

9. A rust-preventive composition as set forth in claim 8 in which said organic medium is a liquid petroleum hydrocarbon.

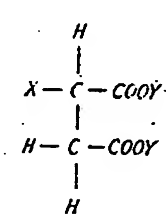
10. A rust-preventive composition as set forth in claim 8 in which said organic medium is a liquid lubricating material.

11. A rust-preventive composition as set forth in claim 8 in which said organic medium is a mineral oil.

12. A rust-preventive composition as set forth in claim 8 in which said organic medium is a liquid solvent.

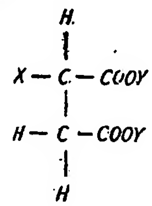
13. A rust-preventive composition as set forth in claim 8 which also contains a minor proportion of an oxidation inhibitor for said organic medium.

14. A rust-preventive lubricating composition comprising a major proportion of an organic lubricant having in solution therein a minor proportion of an ester of an alkyl succinic acid having the general formula



in which X is a straight chain alkyl radical containing at least 12 carbon atoms, one Y is an alkyl radical containing not more than 3 carbon atoms in a straight chain, and the other Y is hydr gen.

15. A rust-preventive cutting oil comprising in solution in a mineral oil a minor proportion of an ester of an alkyl succinic acid having the general formula



in which X is a straight chain alkyl radical containing at least 12 carbon atoms, ne Y is an alkyl radical containing not more than 3 carbon atoms in a straight chain, and the ther Y is hydrogen.

16. A process as set forth in claim 1 substantially as herein described.

17. A rust-preventive composition as set forth in claim 8 substantially as herein described.

HASELTINE, LAKE & CO.,
28, Southampton Buildings, London, England, and
19/25, West 44th Street, New York, U.S.A.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1954
Published at The Patent Office. 25, Southampton Buildings, London, W.C.2, from which copies may be obtained